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Vehicular air pollution and asthma: implications for education for health and environmental sustainability

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ABSTRACT
Studies show a direct relationship between occurrence of asthma and increases of particulate matter in the air. Private transportation is found to be a significant contributor to this problem. The objective of this article is to explore this link between air pollution, asthma and vehicular dependency in order to provide recommendations for health and transport policy. This article focuses on the survey of literature on the relationship between vehicular air pollution and asthma; combining it with the literature on vehicular dependency or 'car culture' in the global context and in The Netherlands. This article exposes the imbalance of power between patient groups and polluting industries, and the government failure to protect the weaker party can be explained by corporate pressures. It will be argued that since air pollution is tied to the corporate support for the car industry and vested interests in promoting a 'car culture', strategic policy that claims to be concerned with public health should explicitly link the present pattern of mobility to public health. This article concludes with a recommendation for raising environmental health awareness by explicitly linking vehicular dependency to respiratory health through a combination of holistic and citizenship education.

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Introduction

Asthma is a chronic respiratory disease, which has changed in recent decades due to both better diagnostic and treatment technologies, and environmental factors, such as pollution or changing lifestyles (Kopnina and Keune 2010, WHO 2014). There is a growing awareness in fields as diverse as medical anthropology and toxicology of the negative effects of air pollution on asthma (Helman 2007, The American Lung Association 2013, NRDC 2014, EPA 2015). With new legal instruments coming into place, including Patients' Rights laws, Charters of the Rights of Patients and Consultation on the Rights of Patients, the World Health Organisation (WHO) has been one of the leading organisations to define principles and strategies for promoting the rights of patients. The WHO also considered environmental pollutants affecting cardiovascular health (http://www.who.int/mediacentre/factsheets/fs313/en/).

The WHO report titled *Health Effects of Transport-Related Air Pollution* (Krzyzanowski *et al.* 2005, p. xii) states that air-related air pollution must be reduced, requiring combining the development of cleaner transport technologies with the implementation of effective policies to manage the demand for transport; and selecting modes of transport that are safer for health and the environment. We shall reflect why few patient organisations put pressure on air-control, pollution-control

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or environmental standards agencies, and the actual polluters, such as the fossil fuel and car industries. Below, we shall explore the challenges of meeting these targets, inquiring why the growing awareness does not seem to counteract the negative effects of vehicular pollution.

This article focuses on the relationship between asthma and vehicular air pollution and awareness of the link among the patient organisations and the public. In explaining low awareness or willingness to act on the part of the patients, this article turns to the phenomenon of the "car culture". Consequently, this article explores the reasons why patient organisations have failed to put sufficient pressure on international environmental and health organisations, and national environmental ministries, as well as the actual polluters such as the automobile industry. This article culminates with a reflection on massive corporate support for the ongoing use of motor vehicles, whereas the significant causes of asthma are hardly addressed. This article uses desk research to elicit data, with the literature from the topic fields of environmental health, transportation and policy. In particular, it surveys the literature on the relationship between vehicular air pollution and asthma, combining it with the brief survey on vehicular dependency. A more specific literature on the effects of air pollution on asthma in the Netherlands is examined. Tying these themes together, holistic health and environmental education is discussed. The concluding section discusses a combination of holistic and citizenship education that could be helpful in fostering awareness of the health risks of vehicular pollution.

Asthma and air pollution

Air pollutants include ozone, found in smog, NO_2 and other particulate matter, such as dust, soot, fly ash, diesel exhaust particles and smoke (e.g. Morris *et al*. 2000, Salam *et al*. 2008, Balmes 2009, Tramuto *et al*. 2011, NRDC 2014). Increasingly, research shows a quantity-based relationship between vehicular pollution and asthma. Studies show a direct relationship between the number of hospitalisations for asthma and increases in particulate matter in local air. For example, the Center for Disease Control and Prevention (CDC) has linked asthma to air pollution, and the Environment and Human Health report, *The Harmful Effects of Vehicle Exhaust: A Case for Policy Change*, has called for immediate policy changes in order to improve respiratory health (Wargo *et al.* 2006).

There is strong evidence associating the development of asthma with residence near roads that have heavy traffic and especially those used by diesel-fuelled vehicles, which are the source of most particulate matter pollution (Independent 2004, EHHI 2005, Krivoshto *et al*. 2008, Tramuto 2011, Vidal 2013). These trends in adult asthma are equally true of childhood asthma. Studies show a clear correlation between exposure to particular matter and exacerbation (or first-time occurrence) of childhood asthma (GINA, Zmirou *et al*. 2004, McConnell *et al.* 2006). A recent study by Volckens *et al.* (2015) demonstrates that in-transit exposure to particulate matter causes worsening of childhood asthma. There is also growing evidence of asthma in children who live near congested roadways (Van Vliet *et al.* 1997, Venn *et al*. 2001, Nicolai 2003, Jerrett *et al*. 2008, Kim *et al*. 2008, Li *et al.* 2011). Simultaneously, there are also serious health risks associated with the use of asthma medication, particularly the long-acting beta-agonists in most prescribed inhaled corticosteroids or ICS (e.g. Nieto *et al.* 2007, Ducharme *et al*. 2010, Kopnina 2010, Jacobs *et al*. 2012). These risks become more pronounced when the ISC is used over long periods of time (Saag *et al.* 2015), and the long periods of use are in turn associated with exposure to asthma stimulators, such as particulate matter (EHHI 2005, EPA 2015).

Aside from the links between inhalation of harmful fumes and incidence of such diseases as asthma and cancer, there is an obvious toll claimed by traffic accidents – with approximately 1.24 million deaths and millions more serious injuries occurring on the world's roads in 2010 (http://www.who.int/gho/road_safety/mortality/traffic_deaths_number/en/). Besides death and injuries, car driving also has been linked to health issues because of the lack of movement of the drivers, affecting their muscular and cardiovascular systems and causing obesity (Jacobson *et al.* 2011).

The very process of car production causes immediate pollution and far-reaching effects such as climate change (UCSUSA 2015). Threats to respiratory health being ushered in by climate change include harmful disease interactions (so-called comorbidity) sparked by changing environmental conditions (Singer 2013). Another consequence of having over a billion cars in the world is that an increasing area of the land is covered by tarmac, allowing less green "filtering" (Sperling and Gordon 2009, Kopnina and Keune 2010, Kopnina 2011). Despite all this evidence, the Union of Concerned Scientists (UCSUSA 2015) has warned that public awareness of the link between cars, climate change and health is still in the development stage. Yet, this is the type of awareness development that needs to be tackled further, as Adlong and Dietsch (2015, p. 687) suggest, linking climate change and environmental health education. Stating that "Evidence indicates that the combustion of coal for electricity is responsible for over 200,000 deaths globally per year" and that "Reducing such deaths is a health co-benefit of greenhouse mitigation actions that promote renewable energy or energy efficiency", Adlong and Dietsch (2015, p. 687) conclude that

> health co-benefits of mitigation and the health risks of climate change strengthen the calls from climate action networks for cleaner energy production – thus reframing climate change as a health issue to environmental movements and to environmental education and environmental education research.

What then drives this car dependency?

The automobile and fuel industries have successfully found creative ways to highlight their products' appeal based not only on the products themselves, but also on associated qualities such as customers' desire for power and control as well as self-esteem – basically, with the car as a marker of social identity (Van Vugt *et al*. 1995, Tertoolen *et al*. 1998, Abrahamse *et al*. 2009, Cairns *et al.* 2014). Almost universally, despite the differences in their religious, cultural or social values or ideologies, Ukrainian, Zimbabwean, Brazilian, Japanese, Turkish and Dutch citizens do not seem to be prepared to give up their cars for the sake of religious or ideological ideals (Kopnina 2013). The widespread desire of human beings to distinguish their status and identity with the markers of material possessions has had unintended negative effects on ecological sustainability and human health (Rees 2008). However, "conspicuous consumption" (the term was coined by Veblin in 1902) has not always been universal, but reflective of a need generated within a particular historic context and mode of production – thus, a learned or culturally mediated trait.

The idea that the car provides its driver with not only mobile independence, but also a sense of personal identity (as a driver of this or that particular type of vehicle) as well as enjoyment was also linked to the increasingly global appeal of cars (McShane 1994, Holtz Kay 1997, Lefrançois 1998, Stradling *et al*. 1999, Sandqvist and Kriström 2001, Cairns *et al.* 2014). Holt and Thompson (2004) examined various motives for car use, reporting on drivers' expressed feelings of sensation, power, superiority and arousal, particularly linked to masculinity.

Holt and Thompson (2004) reflect that men construct themselves as masculine through their consumption and behaviour, particularly in relation to cars. In the case of female drivers, a Turkish study shows that both genders can have masculine and/or feminine characteristics and that female drivers might be attracted to masculine features (Türker and Lajunen 2006). As a popular discussion of the prohibition of female drivers in Saudi Arabia shows, driving is discussed almost as a human right, and linked to the ideas of Western freedom and identity (e.g. Cohen 2015).

It appears that psychological attachment to cars, and the automobile industry's calculated grip upon the market are not deterred by concerns about road safety, environmental sustainability and many other negative effects of cars. Equating "mobility" to "modernity" and freedom also relegates the millions of people and animals killed every year on the roads to a category of accidents. While human traffic accident victims are mourned, their death is not blamed on cars (Oatman-Standford 2014), and animal roadkill is simply seen as "collateral damages" (Desmond 2013). As Oatman-Standford (2014) states:

> Over the past hundred years, as automobiles have been woven into the fabric of our daily lives, our legal system has undermined public safety, and we've been collectively trained to think of these deaths as unavoidable 'accidents' or acts of God. Today, despite the efforts of major public-health agencies and grassroots safety campaigns, few are aware that car crashes are the number one cause of death for Americans under 35.

In a similar way, the health risks caused by car exhaust are ignored, or made invisible by the agency of harm. Sometimes the risks are mediated through technological improvements, such as the development of electric cars (e.g. Verma *et al.* 2015, Weiller and Sioshansi 2015), without public discussion of real costs.

Ecological modernisation proponents and clever car manufacturers introduce various schemes to encourage "ecological driving", alternative fuels, CO_2 taxation and car-related noise reduction (Isenhour 2010). However, opponents point to the "rebound effect" of such technologies, namely, (1) an increase in the number of vehicles; (2) an increase in fuel consumption in response to increases in technical efficiency and (3) an increase in vehicle miles travelled (Greening *et al*. 2000). According to Isenhour (2010), the increasing affordability of energy-efficient vehicles also drives demand for resource extraction for new car production, regardless of the functionality of existing automobiles. Also, such efficiencies tended to create an illusion that the producers and consumers are already doing enough to combat pollution, thus the problem becomes largely invisible (Washington 2015). While the effects of traffic-related air pollution are not visible enough (any more) in Europe, in China, India and other rapidly developing countries the air pollution has increased exponentially in the last 10 years (The Economist 2015).

Air pollution and asthma in the Netherlands

The Dutch government's environmental Assessment Agency (PBL 2009) has concluded that the contribution of carbon to particulate matter is the highest in urban areas. The average annual increment was about 0.5 $\mu g/m^3$, which is higher than the average European standard. However, from a health point of view, a reduction in carbon in particulate matter is believed to be important (PBL 2009). In the *Summary of the Second Netherlands Research Program on Particulate Matter (BOP II)*, the report of the National Institute for Public Health and the Environment (RIVM) has shown that traffic is a major source of soot and heavy metals, which are two to three times higher along busy streets and roads in the Netherlands (Van der Swaluw *et al.* 2013). Due to high population density (almost 17 million people, with 406 people per km^2 in 2014) and increased car ownership, air quality ranked one of the lowest in Europe between 2008 and 2014 (NRC 2008, EEA 2010, The Economist 2012, EEA 2014).

In his study of the car culture in the Netherlands, Jeekel (2011) concluded that most people who do not own a car (20% of the car-less persons during his study in 2010) simply cannot afford it, and as the incomes go up, the car is normally purchased. In 2013 the car density per 1000 inhabitants was 420, up by 18% in 2000 (CBS 2014). As of January 2014, almost 8 million car owners were registered, in a country of 17 million – thus, most people of driving age had a car (http://www.dutchdailynews.com/8-million-cars/; CBS 2014). Petrol-powered cars dominated new registrations in the Netherlands (Eurostat 2015).

This is remarkable, because the Netherlands is a territorially small country (41,543 km, including water) with a highly developed public transportation system and is an alleged leader in "green growth" and ecological modernisation (OECD 2011, Kopnina 2014). Would those bicycles used by the Dutch residents (more than 1 per person) not account for greener transportation trends? Unfortunately not, and the presence of bike lanes in all major Dutch cities does not stop the continuous expansion of Dutch motorways; nor do these lanes prevent the bikers inhaling car exhaust. A number of studies in *Lancet*, a leading medical journal, demonstrate that in the Netherlands poor air quality correlates with incidences of respiratory illness and death (Brunekreef and Holgate 2002, Hoek *et al*. 2002). The studies of children's perception of cars show a tendency to discount the safety risks or relationship to health associated with cars, as well as complex processes of

socialisation in which children are "initiated" into the driving culture (Nillson and Küller 2000, Kopnina 2011, Kopnina and Williams 2012).

According to the Dutch Ministry of Public Health (RIVM 2014), there were 519,800 (236,800 men and 283,000 women) registered asthma patients in the Netherlands, among whom 115,000 are children. A Dutch study (Van Vliet *et al.* 1997) examined whether motor vehicle exhaust from freeways has an effect on the respiratory health of children, with 1068 children attending schools situated less than 1000 m from major freeways carrying between 80,000 and 150,000 vehicles per day. Results of the study demonstrated that those living closer to the freeway and to greater truck traffic exposure tended to be poorer, underprivileged or members of minority groups. Considering the international studies presented above, it is not unreasonable to assume that the Dutch data are consistent with general patterns of vehicle-related negative effects on respiratory health.

What does this tell us about the potential of linking car dependency and awareness of the negative effects of traffic pollution and other health effects associated with cars? To answer this question, this article will first examine more general trends in the health, environmental justice and anti-toxin awareness movements.

Health awareness movements

The issue of environmental health is related to a larger discussion in the social sciences about environmental justice and studies that show that the poorest people tend to live in the most polluted environments. In the rural areas of the developing world, the poor often have been forced into marginal areas (Sahsuvaroglu *et al*. 2009). Environmental racism typically involves the placement of economically disadvantaged or minority communities in proximity to environmentally degraded environments (e.g. Melosi 1995, Holifield 2001, Singer and Evans 2013).

Environmental racism is also related to "transit racism", as minority communities have higher morbidity rates (among other factors, due to traffic) than white communities and, as a result, are more readily affected by debates over environmental factors and subsequent public health and government efforts (Brown *et al*. 2003). However, not just in privileged but across communities, concerns about the occupational hazards in industrial society have intensified since the turn of the previous century, and a global anti-toxics movement has emerged (Zavestovsky 2010). The publication of Rachel Carson's book *The Silent Spring* in 1962 warned the public about the use of chemical pesticides and their influence on health and environment, and raised awareness of the dangers of environmental chemicals.

One of the earlier examples of such dangers is the so-called Great Smog in London, UK, in 1952: a combination of air pollution and extreme weather conditions which has led to hundreds of lives being lost in less than a year, and to thousands of cases of respiratory diseases (e.g. Bell *et al.* 2004; Kjellstrom *et al.* 2006). All these have caused heightened public awareness of environmental health risks and widespread public protests in Western countries in the 1970s (Zavestovsky 2010). Presently, though, more concerted action is needed to expand this awareness and inspire action, for the sake of social justice, generational equity and health.

Environmental and health education

Education for sustainable development or ESD has evolved into different forms including both environment and health, and encompassing human rights education, development education, health education, holistic education, global education and citizenship education (Wals and Jickling 2000, Wals 2012). Holistic education involves students learning about themselves, about health and about social responsibility (Sambe 2011). It can also involve a combination of environmental and health education (Sauvé and Godmaire 2004), and addresses the link between vehicular dependency and asthma. Holistic education combining environmental and health education is centred on knowledge transmission and behavioural change; viewing the environment not only as an object of

study, civic respect or sustainable management, but also as a collective project that involves various stakeholders (Sauvé and Godmaire 2004, p. 37). Recently, a number of educational activities spanning both the so-called holistic health and environmental health have emerged, seeking to promote the well-being of the whole person – thought, feeling, behaviour, body, and spirit – as well as environment, enabling students to learn the challenges of living as a whole (Sambe 2011) (learning about themselves, about healthy relationships, about social responsibility, about compassion, etc.). Example includes the Institute for Holistic Health Studies (IHHS) at San Francisco State University, which offers a comprehensive programme approaching health and healing from a holistic perspective. Such initiatives that are based on the principle that students find identity and purpose in life by connecting to the community, nature and humanitarian values (Sambe 2011) offer an opportunity to address both the health and sociopolitical aspects involved in the intertwined challenges of health and environmental deterioration. In the framework developed by Sauvé and Godmaire (2004, p. 35), integrated participatory holistic approach seeks to stimulate the development of personal and collective competencies for citizen involvement in improving the relationship between communities and their environment in order to simultaneously promote human health and the integrity of the closely interrelated life systems.

However, holistic education is not without its critics. Some argue that holistic education lacks academic rigour and does not create future leaders, but only collaborators (Sambe 2011). Particularly in the case of tackling established power hegemonies, a stronger citizenship education may be needed to empower students to become knowledgeable individuals committed to active participation in a pluralist society (e.g. Sears *et al.* 1998).

Discussion: connecting the dots

To sum up, a number of recommendations can be drawn. It was argued that the structural basis of current transportation policy in Europe must be changed to ensure future sustainability, focussing not only on revenue, but also on issues concerning the health-damaging effects of traffic, privatisation of transport infrastructure and the social distribution of mobility (Whitelegg 1993). In order to achieve this, the public (particularly the asthma patients) and concerned organisations need to examine psychological resistance to public transport use or the symbolic and affective motives for using cars (Van Vugt *et al*. 1995, Tertoolen *et al*. 1998, Loukopoulos *et al*. 2005, Abrahamse *et al*. 2009). Just seeing asthma causes in isolation from our own – for the want of a better word – addiction to cars, and without realising how this addiction is fed, is not likely to lead to long-term positive outcomes for asthma treatment.Perhaps one of the biggest obstacles to combatting asthma and air pollution is the cognitive disconnect between our own behaviour as transportation users and the resulting ill health. Another disconnect concerns organisations, such as the WHO, which are perhaps not powerful enough to counteract the clever marketing and particularly financial vested interests of power lobbies – dealing with health for the exclusion of factors that actually damage it.

Given the imbalance of power between patient groups and polluting industries, the government failure to protect the weaker party can be explained by corporate pressures (Baer 2009). Air pollution is tied to the massive corporate support for the car industry (Baer 2009, Singer 2013), whereas industrial lobbies have vested interests in promoting a "car culture" (Flink 1975, Tertoolen *et al*. 1998, Abrahamse *et al*. 2009). It could be speculated that strategic policy that claims to be concerned with public health then should explicitly link the present pattern of mobility to public health, assuming that greater emphasis on risk and health will lead to both greater public awareness and more pressure on corporate lobbies supporting private vehicles to revise their promotion of private vehicles. However, such direction might be too optimistic as health awareness movements discussed above have only partially succeeded in bringing about social change or altered existing corporate practices.

While it would be unrealistic to suggest that the public needs to use public transport only and that the governments should prohibit car industries from advertising for the sake of health, some pragmatic recommendations can be made. The starting point of discussion – both at the public and

auto industry levels – could be the idea of "sustainable private transport" (Greening *et al.* 2000, Isenhour 2010). While environmental health and holistic education both represent robust areas in which diagnosis of the compound problems and prescriptions for solutions can be found, the existing or developing technological advances can be seen as complementary to both health awareness and education towards sustainability. Recent technological changes have been so rapid that electric cars, with electricity provided by renewable sources (e.g. Verma *et al.* 2015, Weiller and Sioshansi 2015), or advanced "futuristic" designs involving automated connected cars travelling like a train (e.g. Coelingh and Solyom 2012, Glancy 2015), or even flying cars that would not need roads (Preston and Waterson 2015) are becoming a reality. Ideally, one can imagine a solar-powered flying car that utilises vertical parking to minimise the space it uses, causing neither emissions that affect respiratory health nor problems due to the use of surface roads. While all such suggestions might be read as science fiction scenarios (and many of them are), they can also offer positive and realistic ideas that reach beyond the current state of vehicle unsustainability, pollution and poor health. Such technical innovations can also serve to engage both the governments and the corporate parties interested in earning on innovative designs into not only restrictive and prohibitive, but also progressive policies that address both safety and health.

Another opportunity lies in society itself, particularly in generational change, with attitudes towards cars being socialised from parents to children (Kopnina and Williams 2012), and with the possibility of reversing "autophilia" (love of cars) through education. In the words of Sauvé and Godmaire (2004, p. 37), this type of education will centre on appropriation by citizens of realities that concern them and fosters their cooperation in any effort to define and implement precaution and prevention policies and strategies. This education that can be offered at different levels – from elementary to professional medical schools – can be conceived as political praxis, leading people to question political decisions (or inertia), demand accountability on the part of decision-makers and governments and take part in the political dynamics and the problem-solving process (Sauvé and Godmaire 2004, p. 37). Applied to the case of asthma and vehicular dependency, holistic education that integrates concerns about human well-being and environment, as well as provides active guidance, promises to challenge the present disconnect between the causes and effects of disease, as well as critically examine dichotomies between the "perpetuators" and "victims" of air pollution. Students can be inspired both by political empowerment that such an education grants, and the realisation of possibility of change, drawn from both technical solutions described above and a greater understanding of the agencies of harm and reparation.

Since this study was a desk research only, it could be supplemented by a number of empirical studies concentrated on both behaviour and policy of implementation related to environmental health, transport and education. Particularly important for consequence research would be the cases demonstrating correlations between efforts to combat air pollution and respiratory health, positive examples of holistic education, as outlined above and examples of technological innovation leading to cleaner roads and airways.

Conclusions

It appears that psychological attachment to cars, and automobile industry's calculated grip upon the market are not deterred by concerns about road safety, environmental sustainability and many other negative effects of cars. Adult asthma patients and parents of children with asthma need to be made more aware of the direct connection between private transport use and the occurrence of asthma. It is also important to address existing attitudes towards transportation in children. Making this additional health concern more explicit, some progress in reducing car dependency can be made.

In order to enable this change, ideally, concerted efforts of the public could reinforce the positive loop of awareness and action by informing governments' strategic policy, involving awareness not just of the effect of air pollution on asthma but of the powerful stakeholders involved in disseminating car culture, and our own addiction to it. Crucially, the international health organisations as well as

national health ministries, patient organisations, and general public must explicitly address the link between vehicular dependency, air pollution, and asthma. Education can help enable such a change, as suggested by Sauvé and Godmaire (2004) whose framework of integrated holistic education combines different theoretical elements from the principal contributing educational fields: environmental education, health education and risk education. In the context of asthma and vehicular pollution, integrating reflection into action would mean translating knowledge about causes of the disease and car culture's role into a concrete decision to perhaps switch to public transport.

Simultaneously, as Sauvé and Godmaire (2004, p. 44) suggest, we need to foster a sense of belonging to the web of life, to our biotic and human community; and to adopt a critical perspective on socio-environmental and health realities. Concretely, if love of cars can be learned, it can also be unlearned – just like the Dutch bikers learned to dodge each other while turning sharp corners. Their ride would be more pleasant in clean air.

Disclosure statement

No potential conflict of interest was reported by the author.

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